

recovery of energy, such as energy for compression of gas stream 20 and/or stream 9 before air separation. In an embodiment, hot expander 6 and at least one compressor associated with air separation unit 1 are mechanically linked. In such a linked embodiment, as depicted in Fig. 1, expansion of stream 13 rotates a shaft that turns compressor 7 and/or compressor 8, thereby recovering energy of expansion.

Now referring to Fig. 2, an illustration of an alternate embodiment of an integrated air separation unit with a blast furnace, a combustion chamber 32 is shown for heating, by direct heat exchange, stream 31 from air separation unit 30. A fuel 34, such as off gas 16 from blast furnace 2 (shown in Fig. 1) or other hydrocarbon, is burned in combustion chamber 32 to heat stream 31 to produce a heated product stream 36 that is hot expanded in a hot expander 35 to recover energy.

Oxygen containing stream 33 is fed to combustion chamber 32 for combustion with fuel 34. Stream 33 may be atmospheric air or any oxygen containing product, such as an oxygen rich stream. Various embodiments can include a bypass 39 to allow bypass of at least a portion of stream 33 around chamber 32.

Now referring to Fig. 3, an illustration of an alternate embodiment of an integrated air separation unit with a blast furnace, a low pressure combustion chamber 40 is disclosed. In embodiments of this type, fuel 49, such as off gas 16 of Fig. 1, is fed at low pressure, and does not necessarily require further compression, and combusted in chamber 40 to provide heat for heater 44. Heater 44 heats gas stream 43, by indirect heat exchange, which is then hot expanded in an expander 45 to allow for recovery of energy. In various embodiments, the exhaust gas of expander 45 can be sent to a heat recovery exchanger to preheat stream 43 to improve the fuel efficiency of the process.

The present invention also discloses a process of integrating a blast furnace and an air separation unit. Embodiments of processes of the present invention increase blast furnace